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Geoinformatics Based Groundwater Prospects and Quality Study in Mewat District, Haryana, India

DEPARTMENT OF PHYSICS

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Abstract

Water is prime requirement for the living being. Though, Earth has 71% water but the available fresh water is very less. The urbanization, industrialization and intensive agricultural practices have put pressure on the available fresh water. The southern part of Haryana has already water scarcity which has further aggravated due to urbanization and industrialization in national capital region. The study area i.e. Mewat district lies between $27^0$39' to 28^0 20' N latitude and $76^0$51' to $77^0$20'E longitude and covers 1874 sq. km. The district headquarter is located at Nuh. The district comprises of six blocks namely Nuh, Tauru, Nagina, Ferozpur Zhirka and Punhana. The climate of the district is semi-arid and hot mainly characterized by the extreme dryness of the air except during monsoon months, intensely hot summers and cold winters. Geologically, the district has rocks of Delhi Super Group of Pre-Cambrian age mainly comprised of quartzite and older alluvium and blown sand of Quaternary age. Geomorphologically, the district has structural hill, linear ridge, denudational hill, older alluvial plain, palaeochannels, aeolian plain, valley fills and pediments. Of various techniques, satellite remote sensing and geographical information system are helping in searching of potential sites of groundwater with good quality. In the proposed study, groundwater prospects and quality zones will be delineated and groundwater development and management plan will also be prepared. The findings of the study will be highly useful for searching of new potential groundwater areas with good quality in the district.

Key words: Geoinformatics, groundwater, prospects, quality, Mewat, Haryana

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1. Introduction

Water is essential for survival of living being on the planet earth. In the present context of developmental activities, all the natural resources including water is under stress for availability to all living being. Though, water is 71% on the planet earth's total surface but the availability of fresh useable water is very less. For states like Haryana having extensive demand of water for agriculture sector, it is become need of the hour to locate potential groundwater sites for drinking water as well as agriculture purposes. The southern part of the Haryana state is falling under semi-arid type of climate, because of topographical problem, the canal network is poor and groundwater is the main source for drinking, agriculture, commercial and industrial purposes. The annual rainfall is less and recharge of groundwater is not so good. In the present technological era, new techniques like remote sensing and geographical information system (GIS) plays vital role in locating potential groundwater sites in terms of groundwater prospects as well as good groundwater quality. In the Mewat district of the Haryana state, there are problems of water logging and salinity which are related to the groundwater. There is need of an integrated study for delineating the groundwater potential as well as groundwater quality zones for further development and management of groundwater in the district for increasing population, agriculture and industrial purposes.

1.1 Study Area

Mewat district was formed on 4th April, 2005 as the 20th district of the Haryana state which carved out from erstwhile Gurgaon and Faridabad districts. It lies between 27^{0}39' to 28^0 20' N latitude and 76^{0}51' to 77^{0}20'E longitude and covers 1874 sq. km. The district headquarter is located at Nuh. The district comprises of six blocks namely Nuh, Tauru, Nagina, Ferozpur Zhirka and Punhana.

1.2 Climate

The climate of the district is semi-arid and hot mainly characterized by the extreme dryness of the air except during monsoon months, intensely hot summers and cold winters. During last week of June to September, south-west monsoon causes high humidity, cloudiness and

monsoon rainfall. The period from October to December constitutes post-monsoon season. The cold weather season prevails from December to the beginning of March and followed by the hot weather or summer season which prevails up to the last week of June.

1.3 Rainfall

The annual rainfall varies from year to year. The maximum rainfall is experienced during the monsoon season, which reaches its peak in the month of July. About 80% rainfall is received during monsoon period from June to September. The average rainfall varies from 336 mm to 440 mm in the district.

1.4 Physiography

The district has undulating topography and is more or less bowl shaped. Ridges and hillocks make a semi-circle to the west, south and east of Punhana. The area does not have a general slope and rather shows distinct altitude differences in certain domains. The general slope in the district is NW-SE in the western part and NE-SW in north-eastern part. The central part is more or less flat. Seasonal streams from the hills west of Nuh drain flow towards southeast and fill up the natural depressions in central part of the district. Some topographic depressions in the area give rise to natural lakes like Kotla and Ujina lakes.

1.5 Geology

The district has rocks of Delhi Supergroup of Pre-Cambrian age comprising mainly quartzite. Structural features like folds, faults and joints are dominating in the quartzite rock. The various geomorphic features like structural hill, linear ridge, denudational hill, pediment, valley fill, and palaeochannels are also present.

2. Literature Review

Though the traditional methods of study of groundwater potential and quality are still used but the combination of modern techniques would help in solving the problem in very lucid manner. Remote sensing satellite data have been used by many workers for delineating of groundwater potential zones in various types of terrain.

Jana and Dutta [4] studied groundwater potential in piedmont zone of Mechi Mahananda interfluve in Darjiling district, West Bengal using IRS-1A LISS-II FCC and SPOT-1 geocoded imagery of 1991 and 1992 and delineated different hydrogeomorphic units like terraces, flood plain, piedmont, alluvial fans, palaeochannels, valley fill and abandoned channels. The groundwater potential in piedmont plain, river terraces and flood plains had been observed high. The groundwater fluctuation was very high in upper piedmont plain.

Tiwari and Rai [13] studied hydrogeomorphic units in Dhanbad district using Landsat-MSS data. They used Landsat-5 MSS (multispectral scanner) data of band 2 and 4 and their false colour composite (bands 2, 3 and 4) on 1:2,50,000 scale. They found that the hydrogeomorphic features like linear ridges, residual hills, pediplain, dissected pediplain, buried pediments and lineament could be easily identified and mapped using satellite data. The study shows that the pediplain and buried pediments are promising zones for groundwater prospecting.

Das, et al. [2] used Landsat TM FCC (path-row-140-45 dated: 25.5.86 and 139-46: dated: 18.3.87) on 1:2,50,000 scale for hydrogeomorphological mapping of Keonjhar district, Orissa. They also used digital image processing techniques for generating classified outputs. The features like valley fills, pediments were clearly appeared on the classified image. Directional filtering brought out minor fractures/lineaments in controlling groundwater potential of the area. The groundwater potential was maximum in buried pediments and in the vicinity of lineaments trending NW-SE and WNW-ESE direction.

Ravindran and Jeyram [9] mapped hydrogeomorphological units using IRS-IB LISS II data and evaluated groundwater prospects of each hydrogeomorphologic unit on the basis of lithology, structure, landform and available aquifer data in the Shahbad tehsil, Baran district, Eastern Rajasthan. The study had shown that in the western parts of the area the Vindhyan sandstones (Lower Bhander) in which groundwater occurs under unconsolidated to confined conditions along bedding planes and fracture zones had vast potential for groundwater development through deep bore-wells or dug-cum-bore wells while in the eastern parts where shale dominate, large diameter dug-wells suitable to tap limited groundwater resources.

Kumar and Tomar [5] used IRS 1B LISS-II bands 2, 3, and 4 false color composite (FCC) for.

the preparation of hydro geomorphological maps of Godavari sub-watershed, Giridih, Bihar The basin was broadly classified in to two classes-moderately and deep buried pediplain. The geophysical resistivity survey was conducted at selected locations to know the sub-surface scenario. A correlation was made between the hydro geomorphic units and the resistivity data to assess the groundwater in hydrogeomorphic units.

Venkateswara Rao [14] studied the khondalitic terrain in Viziangaram district of Andhra Pradesh using Landsat TM FCC path 141, row 47 on 1:50,000 scale. Visual interpretation of Landsat imagery was done in order to prepare the hydro geomorphological and lineament maps. Drainage and slope maps were prepared using toposheets. It was observed that groundwater prospects was located in shallow buried pediplains and wash plains (linear belts of depositional landforms on either side of streams and rivers and composed of sediments that are regularly carried down from upland catchments resulting from erosion of mountain slopes and pediments) as these were located on gently sloping uplands situated between the lineaments. Non-potential area was high slope areas near the residual hills. It was also found that low lying areas i.e. beneath the streams transformed into kaoline and acting as barrier preventing lateral movement of groundwater, thus, poor groundwater potential zone.

Murthy and Venkateswara Rao [6] carried out hydrogeomorphological mapping in Varaha river basin using IRS 1A LISS II, 2, 3 and 4 bands false colour composite of 1992 year data. They delineated different hydrogeomorphic units like structural hills, pediment, pediplains, denudational hills, flood plain, valley fills and palaeochannels. The groundwater prospects in structural hills was poor except the fractures where moderate groundwater prospects. In pediment, the groundwater potential was moderate. In pediplain, the groundwater potential was high. In flood plain and valley fill the groundwater prospect was very good and excellent respectively. In palaeochannels, the groundwater potential was excellent.

Obi Reddy, et al. [8] studied Gaimukh watershed in Bhandara district, Maharashtra using IRS-1C LISS-III standard false colour composite of 3 March, 1997 on 1:50,000 scale for the preparation of groundwater potential map. The map showed that deep valley fills with thick alluvium had excellent, shallow valley fills and deeply weathered pediplains with thin alluvium

had very good and moderately weathered pediplains had good groundwater potential. These units were highly favourable for groundwater exploration and development. The shallow weathered pediments and pediplains had moderate and limited groundwater potential respectively. The structural hills, linear ridges and inselbergs act as runoff zones and had poor groundwater prospect. In intermontane valley fills had medium groundwater prospects.

Subba Rao et al. [12] used IRS-1D LISS-III geocoded false colour composites of bands 2, 3 and 4 of September 16, 1999 on 1:50,000 scale for the preparation of hydrogeomorphological map of Guntur town and surroundings in Andhra Pradesh. They identified shallow weathered pediplain, moderately weathered pediplain, deeply weathered pediplain, residual hill and lineaments. The results showed that shallow weathered pediplain, moderately weathered pediplain and deeply weathered pediplain had poor to moderate groundwater prospects and residual hill had poor groundwater prospects. Lineaments parallel to the stream courses and intersecting lineaments had favourable indicators for groundwater development. The lineaments can also be utilized to augment groundwater resource.

Sankar [10] studied the Vaigai River basin Tamil Nadu for groundwater potential zones using IRS LISS-III geocoded data on 1:50,000 scale. The geology, geomorphology, lineament tectonic maps were generated and integrated to evaluate the hydrogeomorphical units. A number of geomorphic units had been observed in the Vaigai river basin and found that more groundwater potential units were buried pediment medium, buried pediment deep, flood plain, bajada and lineament and non-potential areas were pediment, pediment inselberg, shallow pediment and pediplain.

Bahuguna, et al. [1] used IRS LISS-II (Bands 2, 3 and 4) FCC of the year September 1992 and January 1994 to map hydrogeomorphology of Bhikangaon area of Khargone district in Madhya Pradesh. They mapped different hydrogeomorphic units like plateau-moderately deep weathered, plateau-shallow deep weathered and denudational hills. It was observed that fractured and weathered rocks were more productive in groundwater discharge as well as lower elevation zones had better groundwater prospects.

Gopinath and Seralathan [3] studied Muvattupuzha river basin using IRS 1D LISS III data. They delineated valley fills, moderately dissected plateau, pediments, residual mounts, residual

mount complex, linear ridges, residual hills and structural hills. Majority of lineaments trends in NW-SE and WNW-ESE direction. The pump test data analyses of dug wells from different hydrogeomorphic units confirmed that valley fills were most promising unit for groundwater prospecting in the basin.

Srinivasa Vittala, et al. [11] studied the North Pennar river basin around Pavagada, Karnataka using IRS 1C and 1D geocoded FCC of LISS III and PAN fused satellite data. They delineated different hydrogeomorphic units like denudational hills, residual hills, inselberg, pediment inselberg complex, pediments, shallow weathered pediplain, moderately weathered pediplain and valley fills. The groundwater potential in valley fills and moderately weathered pediplain were very good to good, in shallow weathered pediplain good to moderate, pediment inselberg complex and pediments moderate to poor and denudational hills, residual hills and inselberg poor to very poor groundwater prospects.

Nag [7] used IRS-1B LISS-IIA data of March 27, 1994 on 1:50,000 scale to delineate hydrogeomorphological units in Baghmundi block in Purulia district, West Bengal. Hydrogeomorphologically, the entire area was classified into very shallow weathered pediment, moderately weathered pediment, structural denudational hills, valley fills, erosional gullies, lateritic upland and accumulation gullies. The groundwater potential in structural denudational hills, accumulation gullies and erosional gullies was poor, in lateritic upland mainly poor, in buried pediment and shallow buried pediment good and in valley fills very good.

3. Description of Broad Area

It is well known that satellite data gives the terrain view in different spectral bands which can be used for mapping of various natural resources. The GIS has the capability to handle spatial data and present in meaningful way in the form of maps. Thus, the data generated with the help of satellite image can be presented in the form of map with the help of GIS. In the present study, remote sensing satellite data and geographical information system (GIS) will be used to map groundwater prospects and groundwater quality scenario in the Mewat district, Haryana.

3.1 Problems in the study area

The study area has following problems related to groundwater:

i. In the district, groundwater is saline and the availability of fresh drinkable water is mostly on foothill zones.

ii. The waterlogging at few places is another problem in the district. The water logging is due to natural depressions in the topography of the district.

iii. The water table depth is going on deeper in north-western part in the district.

4. Problem Identification/Objectives of the Study

Based on above mentioned problems, it is concluded that there is need to delineate groundwater potential zones as well as good groundwater quality areas in the district for fulfilling the need of the increasing population, agriculture and industrial sectors.

Thus, the objectives of the study will be as below:

i. Groundwater prospects delineation using satellite data.

ii. Groundwater quality zonation based on secondary data.

iii. Groundwater development and management plan preparation.

5. Methodology

The various works to be done are given below:

Phase 1: Studying the detailed literature survey relevant to the research topic.

Phase II: Collection of secondary data and maps.

Phase III: Preparation of various thematic maps with the help of toposheets and satellite data of various themes like geomorphology, geology, structure, drainage, water bodies, settlement and road.

Phase IV: Ground truth for field checking of interpreted features.

Phase V: Field information incorporation in the pre-field maps and final thematic maps preparation.

Phase VI: Integration of thematic layers like geology, structure, geomorphology and drainage for preparation of groundwater prospects map and area calculation of various prospects zones.

Phase VII: Input of secondary groundwater quality data in GIS and interpolation of various available quality parameters for preparation of parameter wise quality maps and area calculation of each groundwater quality classes.

Phase VIII: Integration of all the quality parameter layers and integrated groundwater quality map preparation and area calculation of various quality classes.

Phase IX: Groundwater management and development plans preparation based on groundwater prospects map.

Phase X: Interpretation of all the data and drawing of conclusions.

Phase XI: Thesis writing.

The various steps of methodology are shown in fig.1.

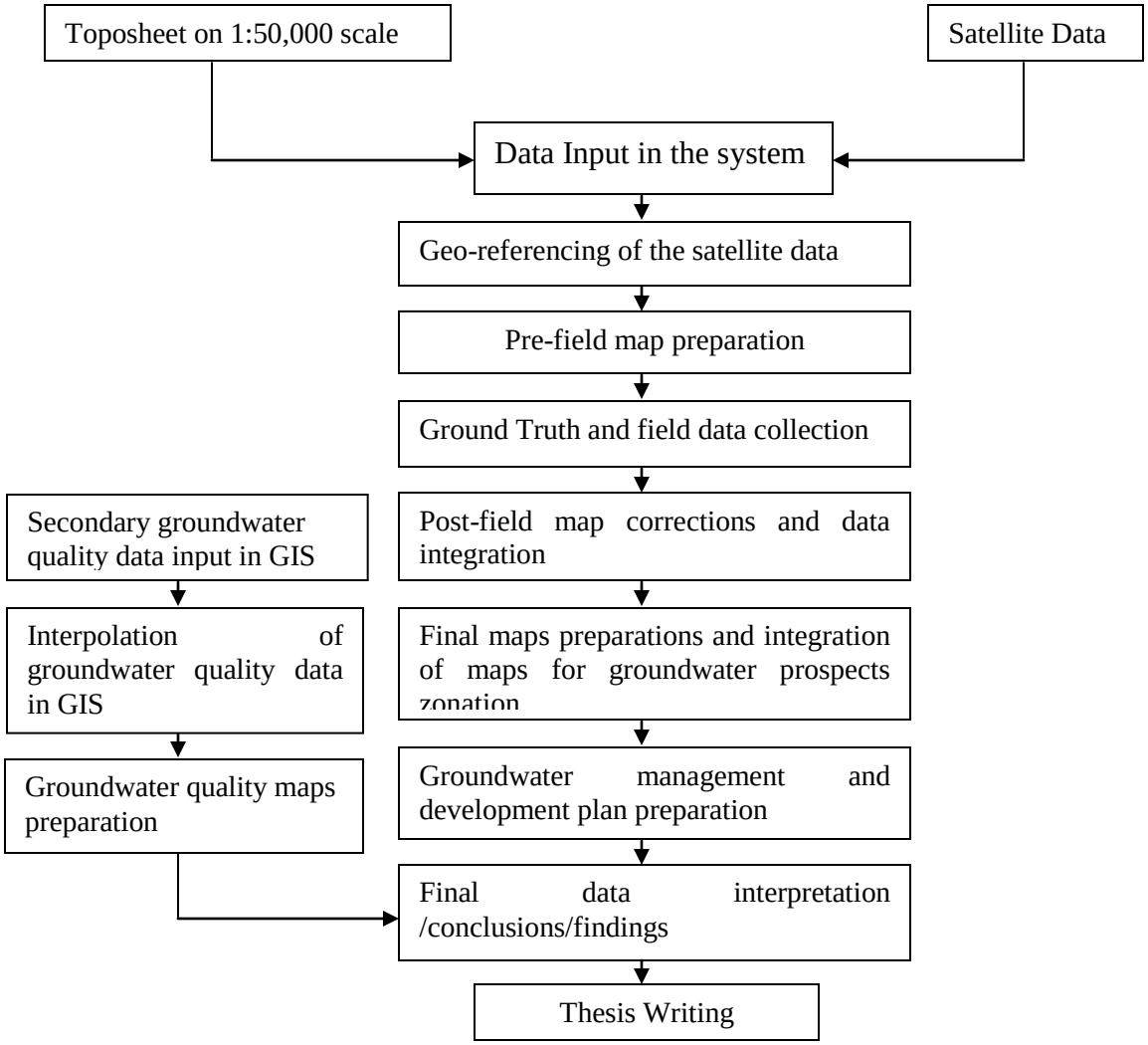
Toposheet on 1:50,000 scale
Satellite Data
Data Input in the system
Geo-referencing of the satellite data
Pre-field map preparation
Ground Truth and field data collection
Secondary groundwater quality data input in GIS
Post-field map corrections and data integration
Interpolation of groundwater quality data in GIS
Final maps preparations and integration of maps for groundwater prospects zonation
Groundwater quality maps preparation
Groundwater management and development plan preparation
Final data interpretation /conclusions/findings
Thesis Writing

Fig.1: Flowchart of Methodology

6. Expected Outcomes of the Research

i. Digital thematic maps like geomorphology, geology, structure, drainage, water bodies, and base information (road, settlement and canal).

ii. Digital database on groundwater prospects of the district.

iii. Digital database on groundwater quality parameters and integrated groundwater quality scenario in the district.

iv. Groundwater management and development plans of the district.

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